PRECIPITATION DATA ANALYSIS FOR SINCLAIR/DYES INLET FOR WATERYEAR 2003

(WY2003 October 1, 2002 – September 30, 2003)

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INTRODUCTION

This document was prepared as supporting information for **An Analysis of Microbial Pollution in the Sinclair-Dyes Inlet Watershed** the fecal coliform Total Maxium Daily Load study conducted for Sinclair and Dyes Inlets by PSNS Project ENVVEST. Rain data for water year 2003 (WY2003), from the beginning of October 2002 to the end of September 2003, was analyzed (with the exception of Station 8 which started recording rain in Jan. 2003). The ENVVEST project utilizes 13 rain gages for modeling, correlations, and predictions. Eight rain gage stations are maintained by the City of Bremerton; four stations are maintained by Kitsap Public Utility District (KPUD); one station is maintained by Puget Sound Naval Shipyard (PSNS). The Figure 1 shows the locations of the rain gages, and the exact locations are listed in Table 1.

APPROACH

Rain events can be classified as to their reoccurrence interval. The National Oceanic and Atmospheric Administration (NOAA) bases the frequency on the probability that an event will occur within 2 years, 5 years, 10 years, 25 years, 50 years, or 100 years. The precipitation data is either summed in a 6 hour or 24 hour period. NOAA's Western US Precipitation Frequency maps (http://www.wrcc.dri.edu/pcpnfreq.html) shows isohedrals for the two periods for each frequency interval, for a total of 12 isohedral maps. These maps were then overlayed into ArcMap GIS with each of the 13 precipitation gages. These maps can be found in Attachment A. Table 2 below summarizes each event for the 6 hour period-all frequency events. Table 3 below summarizes each event for the 24 hour period-all frequency events.

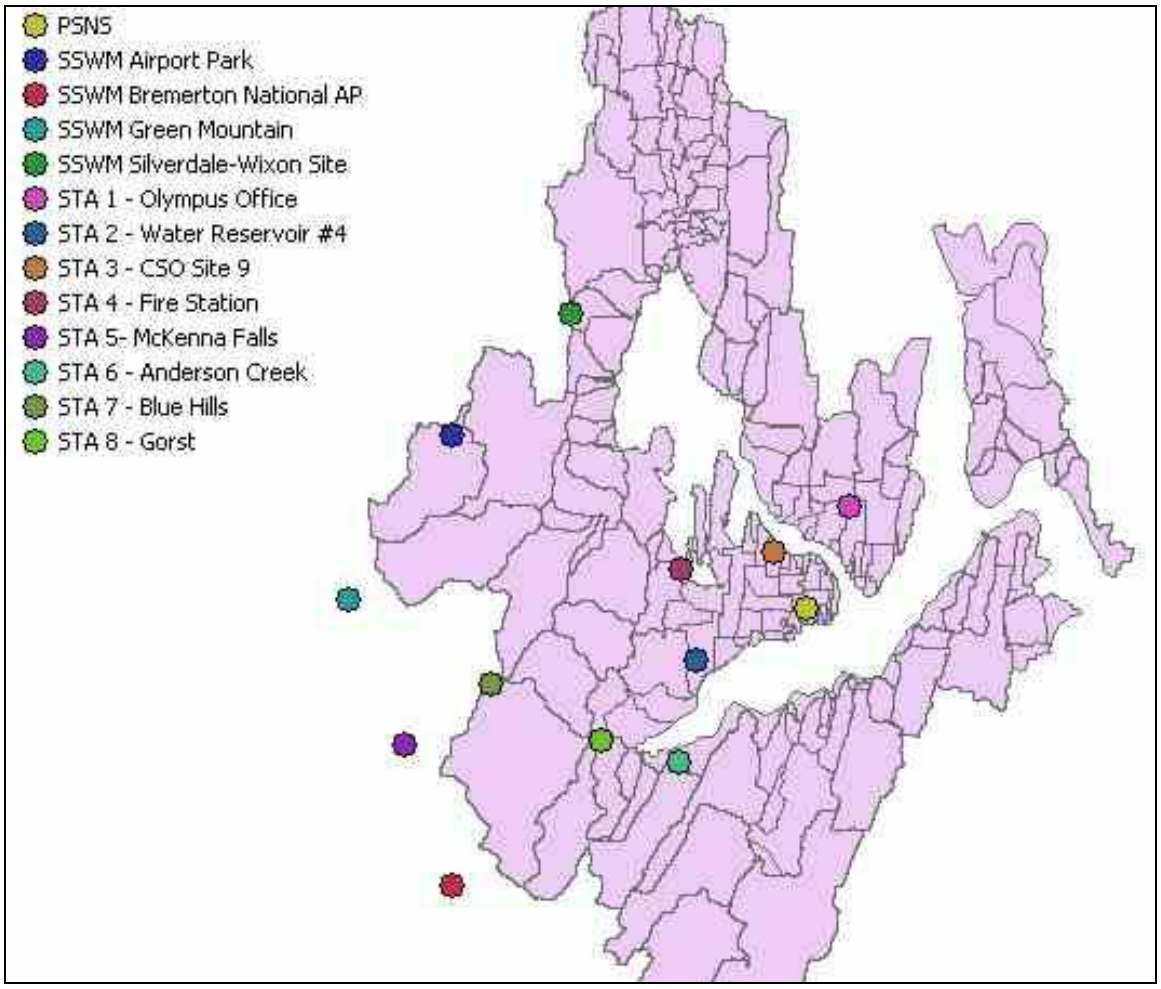

Figure 1: Locations of Rain Gages Near the ENVVEST Study Region

Station	Latitude-y	Longitutde-x	Comments
STA 1 - Olympus Office	47.59000000000000	-122.61916666666700	Olympus Drive
STA 2 - Water Reservoir #4	47.55027777777780	-122.67527777777800	Roosevelt Blvd.
STA 3 - CSO Site 9	47.57805555555560	-122.64722222222200	19th Ave.
STA 4 - Fire Station	47.57333333333330	-122.68250000000000	Kitsap Way
STA 5- McKenna Falls	47.52722222222220	-122.78444444444400	Brem Watershed
STA 6 - Anderson Creek	47.52430555555560	-122.68125000000000	Anderson Hill Rd
STA 7 - Blue Hills	47.54280555555560	-122.75216666666700	Brem Watershed
STA 8 - Gorst	47.52944444444440	-122.71055555555600	Old Belfair Hwy
SSWM Green Mountain	47.56333333333320	-122.80638888888900	kpud sta.60
SSWM Bremerton National AP	47.49194444444440	-122.76527777777800	kpud sta.61
SSWM Silverdale-Wixon Site	47.63750000000000	-122.72583333333300	kpud sta.62
SSWM Airport Park	47.60583333333330	-122.76888888888800	kpud sta.63
PSNS	47.56398000000000	-122.63447000000000	psns

Table 1: Exact Location of Rain Gages Near the ENVVEST Study Region (decimal degrees)

The yearly summary is shown in Table 2 and Figure 2 for each gage along with the percentage of data that is missing. The yearly summary does not include those times that it rained when the rain gage was malfunctioning, etc.

	Yearly Precip (inches)	Percent of Data Missing
Sta 1	39.14	2.00
Sta 2	41.10	3.95
Sta 3	31.61	10.08
Sta 4	45.93	11.88
Sta 5	14.34	56.79
Sta 6	46.31	30.83
Sta 7	32.37	28.07
Sta 8	9.99	61.39
Green	46.96	9.45
Brem	40.92	0.00
Silver	49.46	0.00
Airport	55.37	0.00
PSNS	34.31	0.00

Table 2: Yearly Precipitation and Percent of Data Missing for Each Station

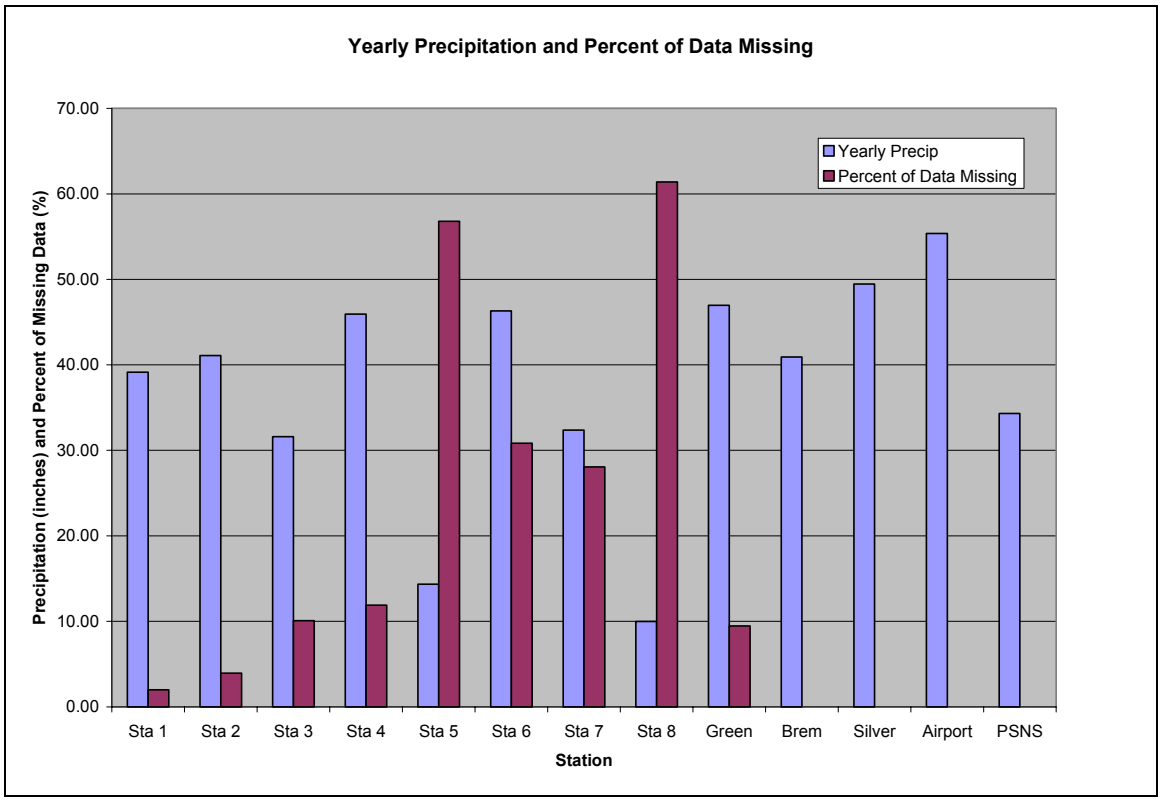

Figure 2:Yearly Precipitation for Each Station

The monthly summary of precipitation is shown in Table 3 and Figure 3. This does not include all precipitation. Red text denotes that month which had missing data. Table 4 shows the percent of data that is missing for each station by month.

	October	November	December	January	February	March	April	May	June	July	August	Sept
Sta 1	0.36	3.8	8.51	11.34	1.21	9.09	3.17	0.96	0.39	0.08	0.23	0
Sta 2	0.43	3.78	8.64	11.8	1.25	9.2	3.79	1.03	0.42	0.1	0.18	0.48
Sta 3	0.4	3.47	7.55	5.59	1.17	8.25	3.26	1.03	0.56	0.07	0.26	0
Sta 4	0.6	4.38	9.29	12.24	1.63	9.95	4.6	0.69	0.82	0.26	0.94	0.53
Sta 5	0.41	3.49	0	8.21	1.34	0	0	0	0	0.06	0.35	0.48
Sta 6	0.57	14.78	9.53	12.2	1.7	6.73	0	0	0	0.01	0.22	0.57
Sta 7	0.7	5.63	9.55	13.19	1.3	0	0	0.23	0.48	0.2	0.34	0.75
Sta 8	0	0	0	8.46	1.43	0	0	0.1	0	0	0	0
Green	0.61	8.35	13.11	15.51	2.19	0.02	4.18	0.83	0.59	0.22	0.37	0.98
Brem	0.29	4.73	7.97	11.76	1.68	8.71	3.96	0.53	0.38	0.1	0.27	0.54
Silver	0.58	5.3	11.13	12.4	1.35	11.92	4.4	1.31	0.48	0.01	0.27	0.31
Airport	0.72	6.56	12.72	13.62	1.72	13.45	4.41	0.81	0.51	0.28	0.26	0.31
PSNS	0.34	1.32	7.71	10.56	1.26	8.49	2.99	0.71	0.3	0.06	0.21	0.36

Table 3: Monthy Precipitation Totals (Note: Does not include all precipitation. Red text denotes that month which had missing data)

	October	November	December	January	February	March	April	May	June	July	August	Sept
Sta 1	0	0	0	0	0	0	23	5	42	0	72	99
Sta 2	0	0	0	0	0	0	0	8	31	0	9	0
Sta 3	0	0	0	0	0	0	22	9	0	0	0	92
Sta 4	0	0	0	0	0	0	0	0	94	38	0	11
Sta 5	0	59	100	33	35	100	100	100	100	29	0	25
Sta 6	0	0	0	0	0	38	100	100	100	29	2	0.03
Sta 7	0	0	0	0	35	100	100	32	30	7	9	25
Sta 8	100	100	100	23	0	0	0	9	100	100	100	98.82
Green	0	0	0	0	0	92	20	0	0	0	0	0
Brem	0	0	0	0	0	0	0	0	0	0	0	0
Silver	0	0	0	0	0	0	0	0	0	0	0	0
Airport	0	0	0	0	0	0	0	0	0	0	0	0
PSNS	0	0	0	0	0	0	0	0	0	0	0	0

Table 4: Percent Data Missing by Month for Each Station

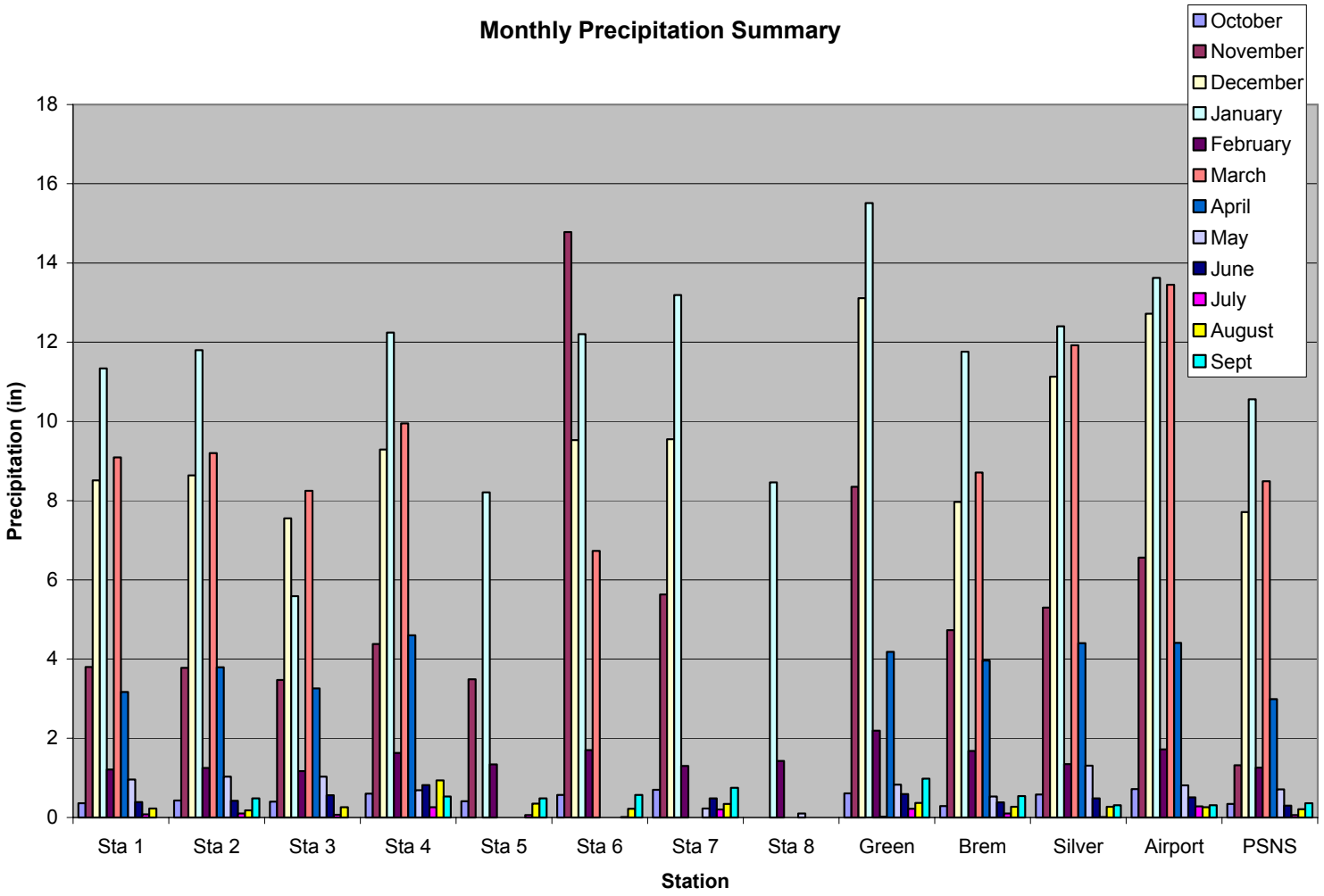

Figure 3: Monthly Precipitation

Frequency Analysis

Rain events can be classified as to their reoccurrence interval. NOAA bases the frequency on the probability that an even will occur within 2 years, 5 years, 10 years, 25 years, 50 years, or 100 years. The precipitation data is either summed in a 6 hour or 24 hour period. NOAA's Western US Precipitation Frequency maps (http://www.wrcc.dri.edu/pcpnfreq.html) shows iso-hedrals for the two periods for each frequency interval, for a total of 12 iso-hedral maps. These maps were then overlayed into ArcMap GIS with each of the 13 precipitaiton gages. These maps can be found in Attachment A. Table 5 below summarizes each event for the 6 hour period-all frequency events. Table 6 below summarizes each event for the 24 hour period-all frequency events.

STATION	2 yr- 6 hr	5 yr- 6 hr	10 yr- 6 hr	25 yr- 6 hr	50 yr- 6 hr	100 yr- 6 hr
Sta.1	1.2	1.6	1.8	2	2.2	2.5
PSNS	1.3	1.6	1.8	2.1	2.3	2.6
Sta. 3	1.3	1.6	1.8	2.1	2.4	2.6
Sta. 4	1.4	1.8	1.9	2.3	2.5	2.7
Sta. 2	1.4	1.8	1.9	2.3	2.5	2.7
Sta. 6	1.4	1.8	2	2.3	2.5	2.7
Sta. 8	1.5	1.8	2	2.4	2.5	2.8
SWMM Silverdale	1.5	1.8	2	2.5	2.6	2.8
SWMM Airport Park	1.6	1.9	2.2	2.6	2.8	3
SWMM Green Mtn	1.7	2	2.3	2.7	2.9	3.2
Sta. 7	1.6	1.9	2	2.5	2.7	3
Sta. 5	1.6	2	2.2	2.6	2.8	3.1
SWMM Bremerton	1.8	1.9	2	2.5	2.8	3

Table 5: 6-hour events for the 13 ENVVEST precipitation gages (inches)

STATION	2 yr- 24 hr	5 yr- 24 hr	10 yr- 24 hr	25 yr- 24 hr	50 yr- 24 hr	100 yr- 24 hr
Sta.1	2.6	3.2	3.5	4.2	4.6	5.2
PSNS	2.7	3.4	3.6	4.4	4.9	5.4
Sta. 3	2.7	3.5	3.7	4.5	5	5.5
Sta. 4	2.8	3.6	4.1	4.8	5.4	5.9
Sta. 2	2.8	3.6	4.1	4.7	5.4	5.8
Sta. 6	2.8	3.6	4.1	4.8	5.5	5.9
Sta. 8	3.2	3.7	4.3	5.1	5.7	6.2
SWMM Silverdale	3.2	3.9	4.4	5.1	5.7	6.2
SWMM Airport Park	3.4	4.2	4.6	5.4	6	6.5
SWMM Green Mtn	3.6	4.4	4.9	5.6	6.4	6.9
Sta. 7	3.3	4.1	4.6	5.4	5.9	6.4
Sta. 5	3.4	4.3	4.8	5.5	6.1	6.6
SWMM Bremerton	3.3	4.2	4.6	5.4	6	6.5

Table 6: 24-hour events for the 13 ENVVEST precipitation gages (inches)

For each event and specific frequency, the range was allowed to vary as much as 0.1” above and 0.1” below the reported numbers in Table 5 and Table 6. For example, for the 10 year-24 hour even for Station 8, the qualifying event would be 4.3” However, for computational purposes, an event from 4.2” to 4.4” would qualify as a 10 year-24 hour event.

The 8 stations maintained by the city were summed on a 6 hour interval basis for the guidelines in Table 5. No event for any of the 8 stations qualified for any event. Therefore, the other 5 gages were not analyzed, nor were the 24 hour interval events. This lead to the event analysis (see below).

EVENT ANALYSIS

The second analysis performed on the WY2003 precipitation data was to group each event. The events were defined as from when they began to when the rain stopped. The rain data was gathered for every 15 minutes, so if there was a 15 minute interval that had a rainfall of "0," that value ended the event. The events were tabulated showing the start date and time of the event, the total rainfall for the event, and the number of 15 minute intervals for that event. These are included in a zip file attached with this report. The events are summarized for the 8 rain gages maintained by the city below.

Rain event range	0.01 to 1.64	inches	
Time event range	.25 to 16.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	601	11.36	0.02
0.11- 0.5	71	15.39	0.22
0.51-1.0	9	5.69	0.63
1.1-2.0	5	6.70	1.34
TOTAL	686	39.14	0.06

Table 7: Statistics for Station 1

Rain event range	0.01 to 1.45	inches	
Time event range	.25 to 14.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	627	12.44	0.02
0.11- 0.5	68	15.67	0.23
0.51-1.0	11	6.60	0.60
1.1-2.0	5	6.39	1.28
TOTAL	711	41.10	0.06

Table 8: Statistics for Station 2

Rain event range	0.01 to 1.3	inches	
Time event range	.25 to 14	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	600	11.15	0.02
0.11- 0.5	70	15.25	0.22
0.51-1.0	4	2.81	0.70
1.1-2.0	2	2.40	1.20
TOTAL	676	31.61	0.05

Table 9: Statistics for Station 3

Rain event range	0.01 to 2.26	inches	
Time event range	.25 to 16.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	686	13.89	0.02
0.11- 0.5	76	17.28	0.23
0.51-1.0	12	7.45	0.62
1.1-2.0	4	5.05	1.26
2.1-3.0	1	2.26	2.26
TOTAL	779	45.93	0.06

Table 10: Statistics for Station 4

Rain event range	0.01 to 1.52	inches	
Time event range	.25 to 12.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	233	4.61	0.02
0.11- 0.5	23	5.58	0.24
0.51-1.0	2	1.40	0.70
1.1-2.0	2	2.75	1.38
TOTAL	260	14.34	0.06

Table 11: Statistics for Station 5

Rain event range	0.01 to 2.19	inches	
Time event range	.25 to 16.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	536	10.75	0.02
0.11- 0.5	61	14.66	0.24
0.51-1.0	8	4.73	0.59
1.1-2.0	3	3.68	1.23
2.0 up	1	2.19	2.19
TOTAL	609	36.01	0.06

Table 9: Statistics for Station 6

Rain event range	0.01 to 2.24	inches	
Time event range	.25 to 15	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	519	9.87	0.02
0.11- 0.5	41	9.57	0.23
0.51-1.0	10	6.19	0.62
1.1-2.0	4	4.50	1.13

2.0 up	1	2.24	2.24
TOTAL	575	32.37	0.06

Table 10: Statistics for Station 7

Rain event range	0.01 to 1.47	inches	
Time event range	.25 to 9.25	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	110	2.05	0.02
0.11- 0.5	16	4.12	0.26
0.51-1.0	2	1.26	0.63
1.1-2.0	2	2.56	1.28
TOTAL	130	9.99	0.08

Table 11: Statistics for Station 8

Rain event range	0.01 to 1.73	inches	
Time event range	0.25 to 17.25	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	672	13.04	0.019
0.11- 0.5	53	11.5	0.217
0.51-1.0	15	11.07	0.738
1.1-2.0	8	11.35	1.42
TOTAL	748	46.96	

Table 12: Statistics for Station Green Mountain

Rain event range	0.01 to 1.2	inches	
Time event range	0.25 to 10.25	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	659	14.49	0.022
0.11- 0.5	76	17.23	0.227
0.51-1.0	8	4.8	0.6
1.1-2.0	4	4.4	1.1
TOTAL	747	40.92	

Table 13: Statistics for Station Bremerton

Rain event range	0.01 to 3.46	inches	
Time event range	0.25 to 20	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	623	12.98	0.0208
0.11- 0.5	65	14.74	0.2267
0.51-1.0	15	10.65	0.71
1.1-3.5	7	11.09	1.584
TOTAL	710	49.46	

Table 14: Statistics for Station Silverdale/Wixton

Rain event range	0.01 to 3.34	inches	
Time event range	0.25 to 19.5	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	622	13.54	0.0218
0.11- 0.5	66	15.03	0.2277
0.51-1.0	14	9.44	0.6742
1.1-3.5	12	17.36	1.4466
TOTAL	714	55.37	

Table 15: Statistics for Station Airport Park

Rain event range	0.01 to 1.37	inches	
Time event range	0.25 to 10.25	hours	
Precip (inches)	No. of events	Precip (inches)	Average precip per event (inches)
0.01-.1	475	9.85	0.0207
0.11- 0.5	63	14.57	0.2313
0.51-1.0	11	7.19	0.6536
1.1-2.0	2	2.7	1.35
TOTAL	551	34.31	

Table 16: Statistics for Station PSNS

Attachment A: Iso-Hyetographs with 13 Rain Gage Stations View

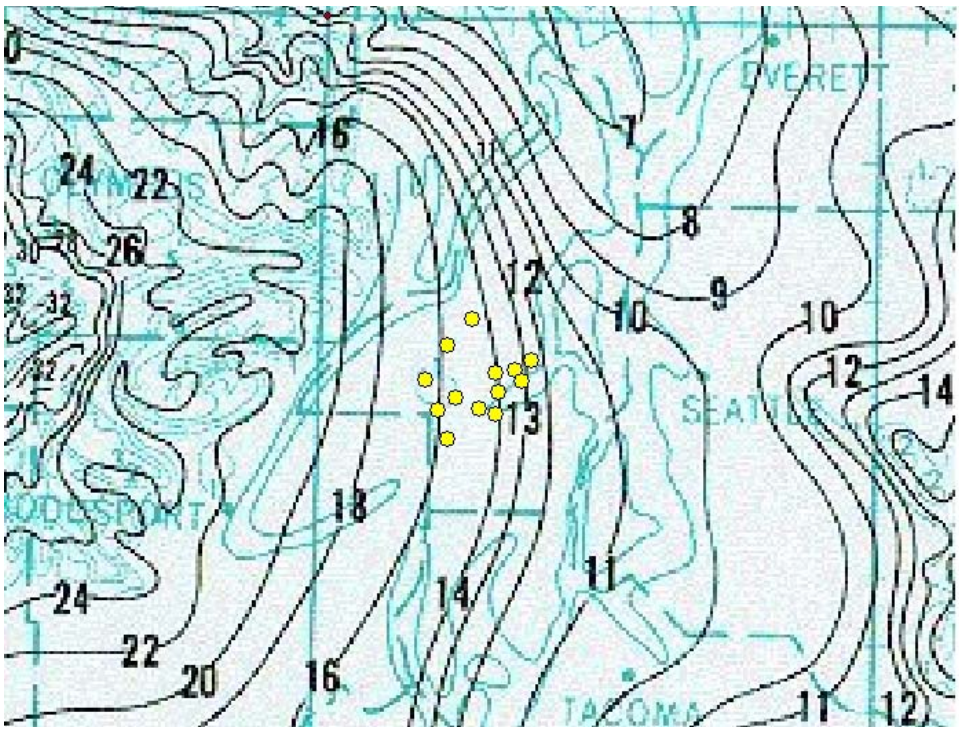

Figure Above: 2 Year 6 Hour

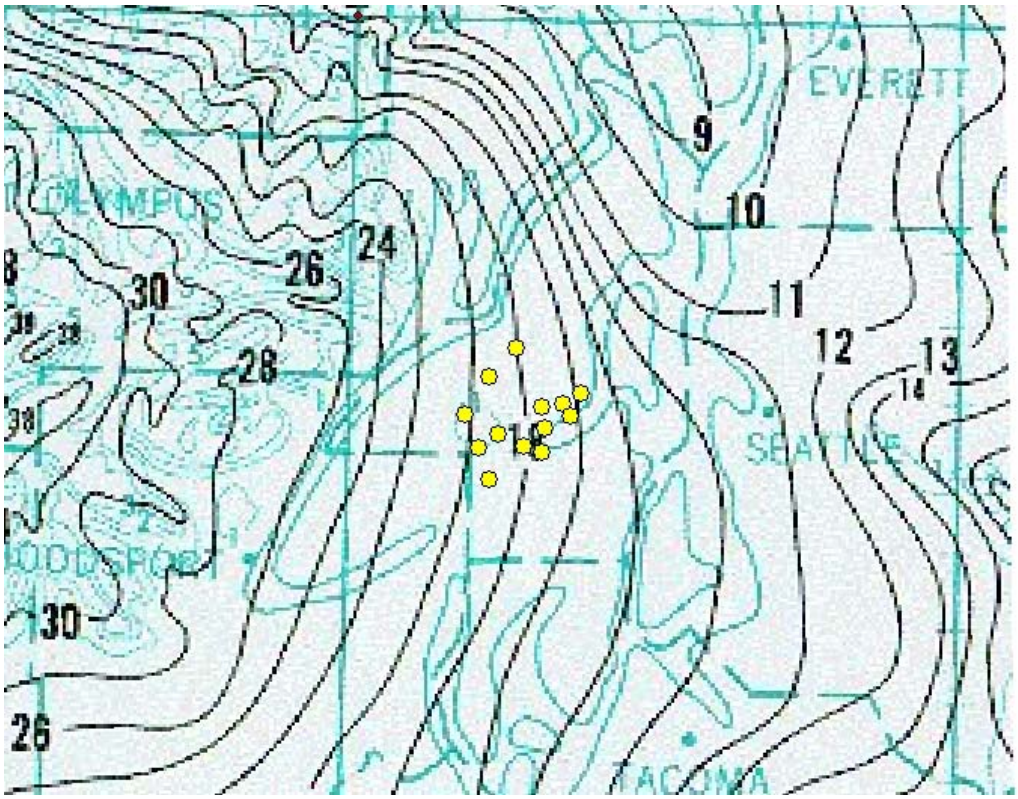

Figure Above: 5 Year 6 Hour

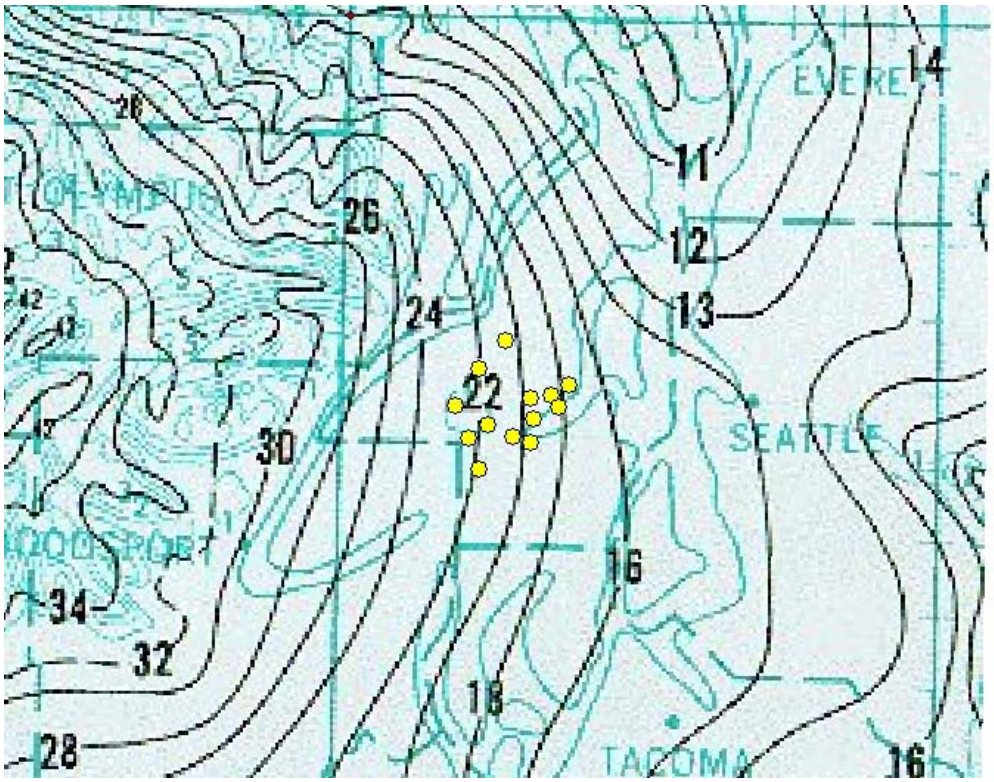

Figure Above: 10 Year 6 Hour

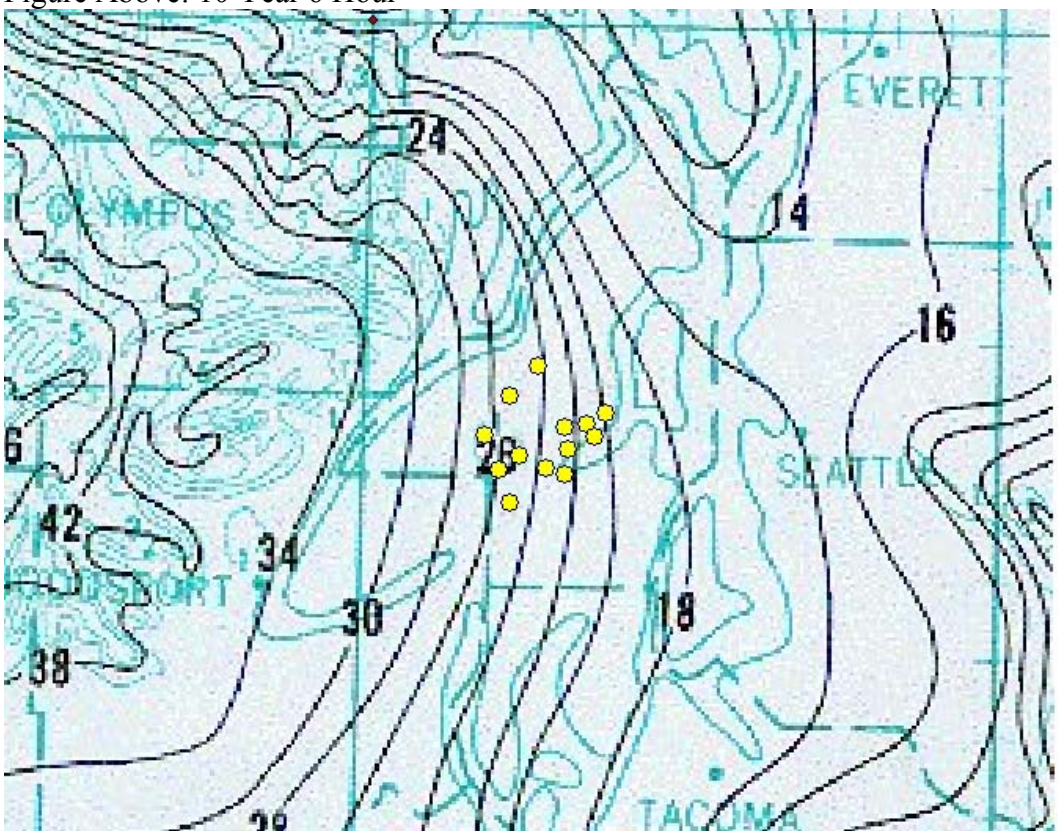

Figure Above: 25 Year 6 Hour

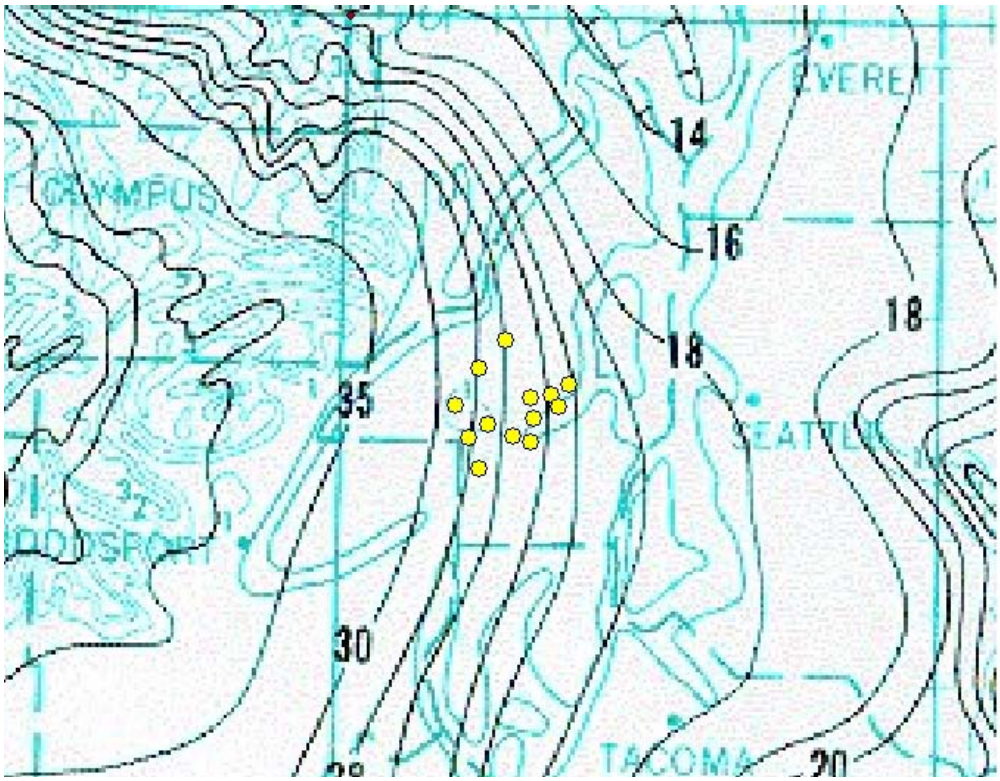

Figure Above: 50 Year 6 Hour

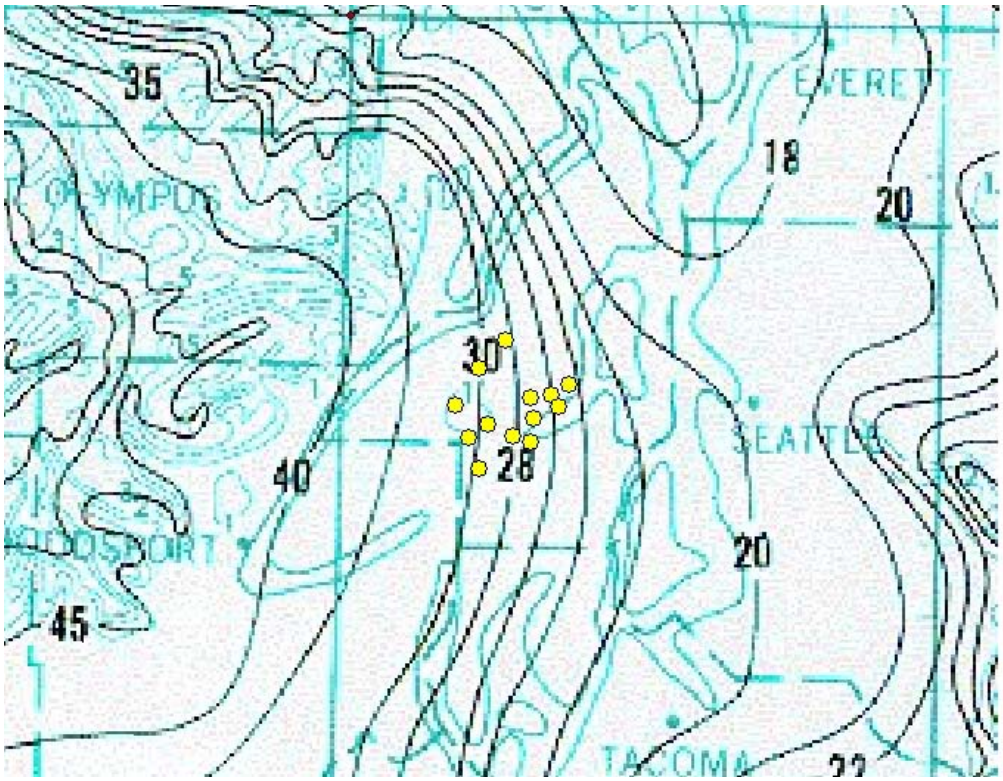

Figure Above: 100 Year 6 Hour

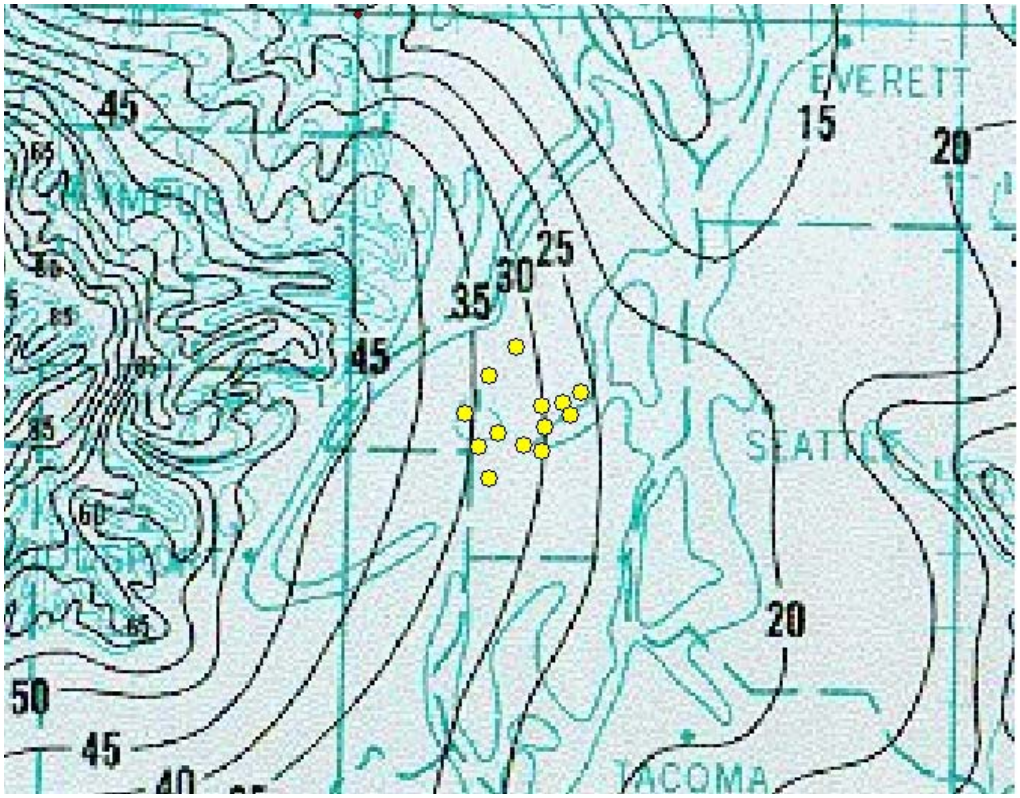

Figure Above: 2 Year 24 Hour

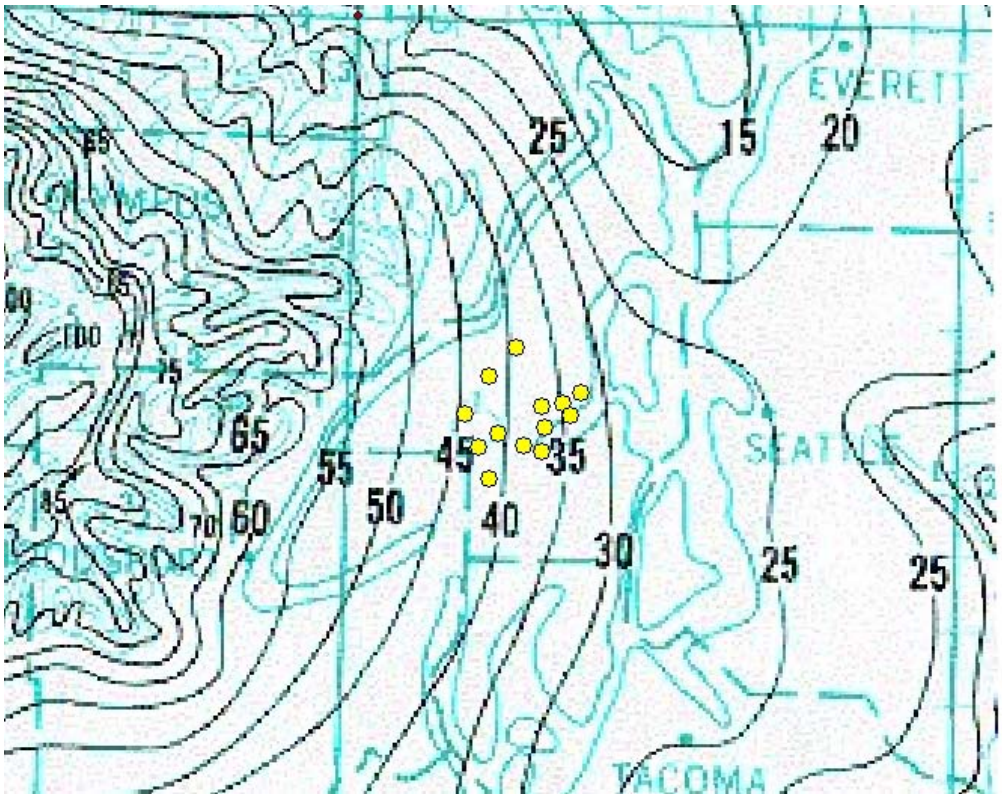

Figure Above: 5 year 24 Hour

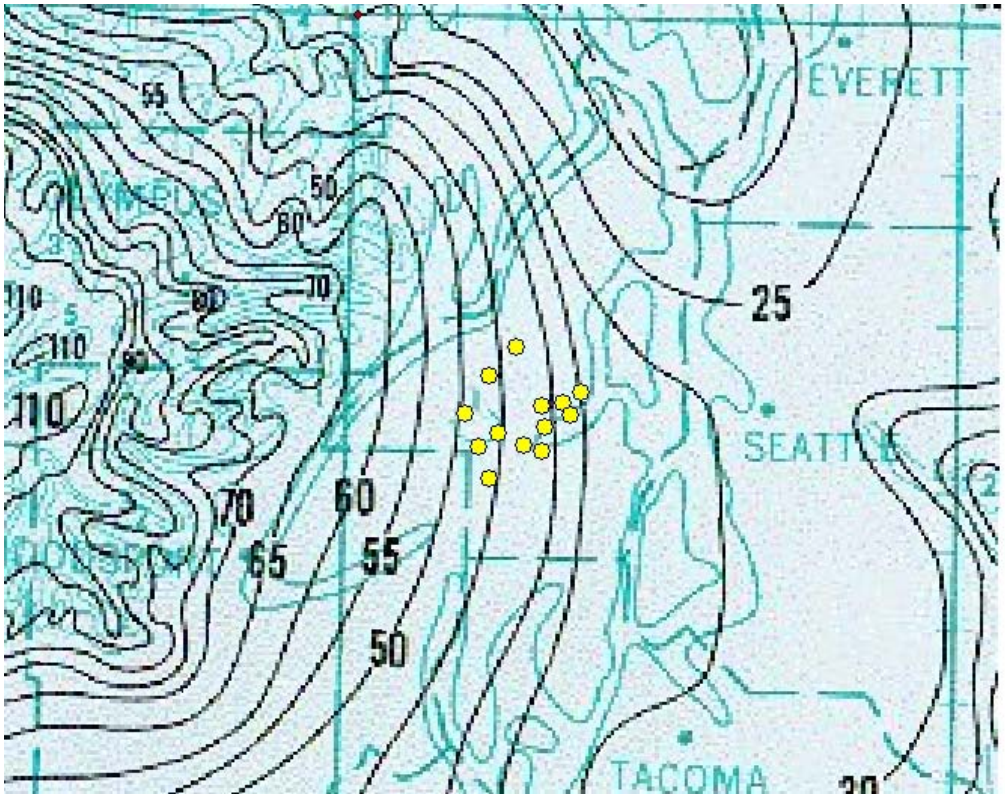

Figure Above: 10 Year 24 Hour

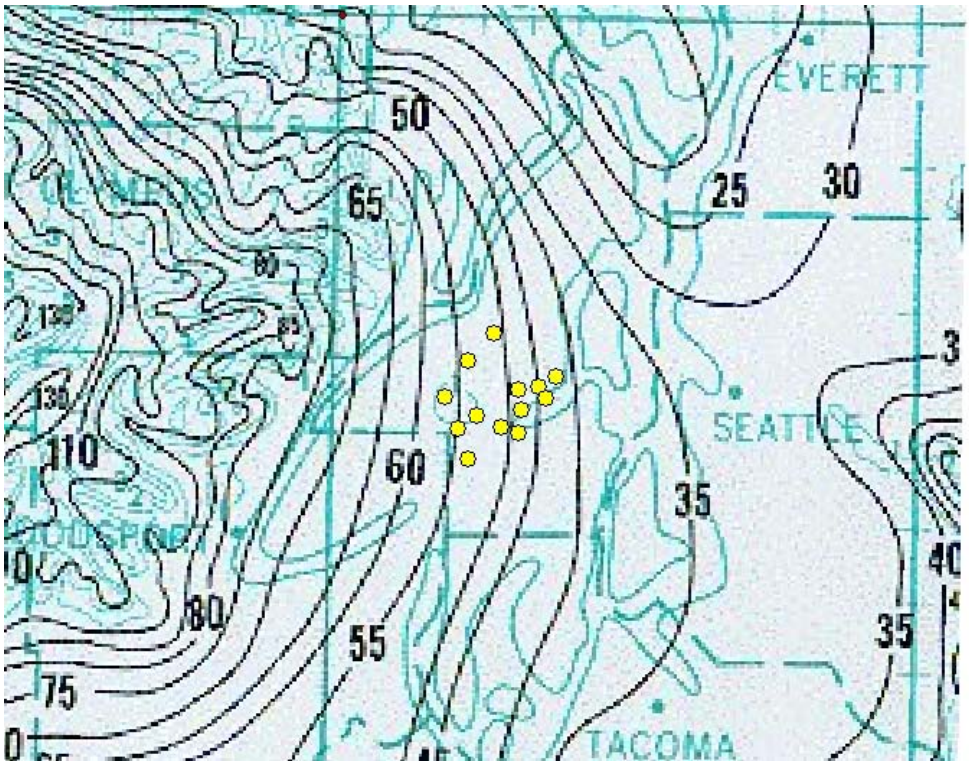

Figure Above: 25 Year 24 Hour

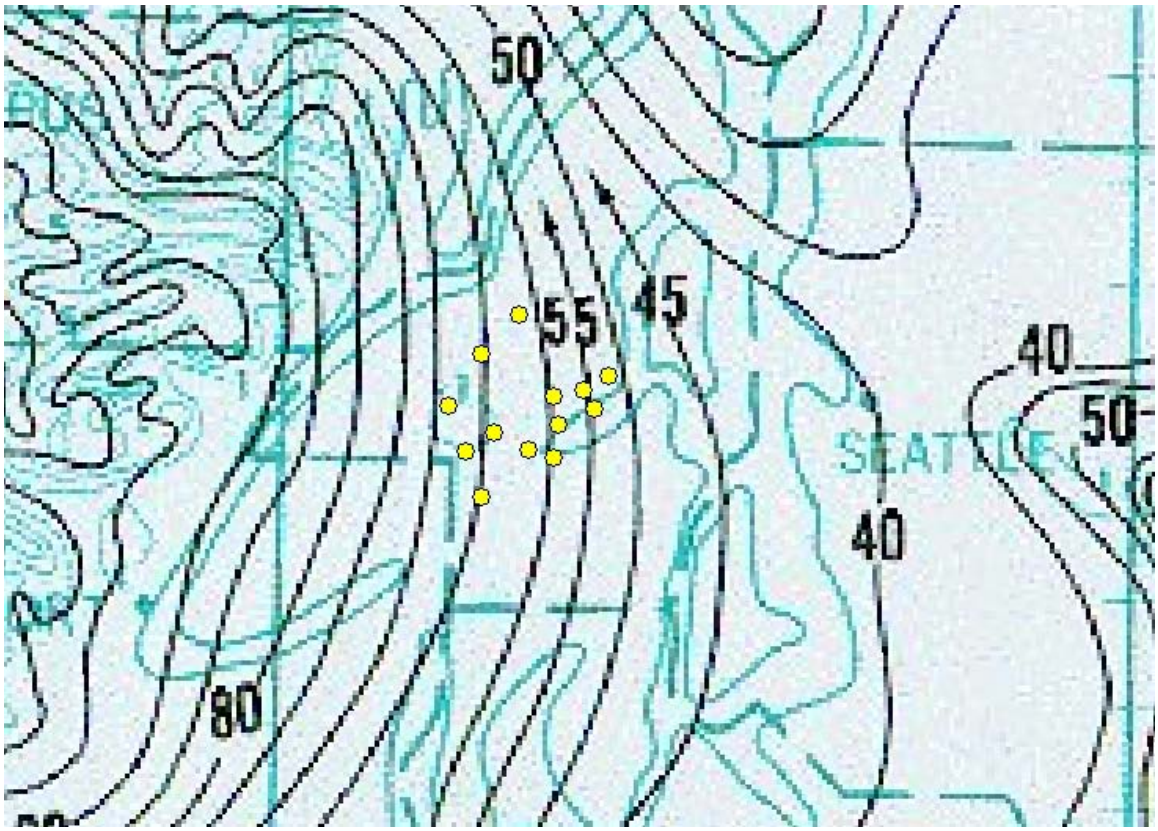

Figure Above: 100 Year 24 Hour